# Industrial Clusters and the Knowledge Based Economy : from open to distributed structures ?

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**Abstract :**
During the recent years, clusters have been at the heart of a vast literature supposed to bring new arguments and perspectives to local development preoccupations. Two complementary factors are stressing for firms and territories the importance of governing the interactions of industrial actors: the globalisation of the economy and the technology and the emergence of a knowledge based economy. In local systems, agents are mostly connected with agents situated in their spatial proximity, while these local networks, as open systems, benefit from the long distance connections that some of their members are able to activate. Co-location of actors in a geographical proximity by itself is not a sufficient condition for co-ordination but can contribute to its efficiency, provided the existence of other shared dimensions among agents: organic level, representations, projects, ... As far as efficiency and performances of "classical" clusters are not only the result of the intensity and quality of internal but also external interactions and coordination, into which extent can we still consider the relevance of interaction structures restricted to bounded geographical areas? In this paper we turn our attention to the way industrial actors take into account the question of the local-global articulation for the strategic building of their own ego-network, that is the set of links they may build in order to achieve efficient interactions with partners and competitors. Thus interfaces between local and global relationships are a key feature that can be achieved through different approaches. To this aim we introduce the two concepts of knowledge gatekeeper and temporary proximity that appear as providing alternative approaches of actors partnering, likely to provide a better flexibility in the local-global trade-off. We will then present the basic form of the ego-networks on which the individual firm is able to build her relational neighbourhood. This raises the question of the combination of individual ego-networks into a consistent networked structure into which local networks are articulated by the way of local-global interfaces. On this basis we present a typology of the basic new forms of clustering where time and space can be alternatively and complementarily combined in order to achieve more flexibility and costs reduction of the localisation game.

JEL : D23, L14, L22, R30

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## *1. Introduction*

During the recent years, clusters have been at the heart of a vast literature supposed to bring new arguments and perspectives to local development preoccupations. Here and there this concern corresponds to the way industrial actors and territories may share interests, drawing benefits from geographical proximity. This is all the more important in a context where individual competitiveness of industrial companies growingly relies on their capacity to establish co-operation relationships with either complementary or competitors partners, opening them access to better resources and markets, costs reductions or common standards setting.

Two complementary factors are stressing for firms and territories the importance of governing the interactions of industrial actors: the globalisation of the economy and the technology and the emergence of a knowledge based economy. It is clear that the immense progresses in transport and communication technologies are a singular challenge to the locality of synergies and the geographical proximity of the actors. On the one hand, today knowledge takes a central place at the core of more and more industrial and innovation processes and, on the other hand, technologies of information and communication have powerfully developed, in terms of performance and infrastructure. Knowledge spillovers, if they have a significant local impact can also affect distant actors by the way of non-geographical proximities.

In local systems, agents are mostly connected with agents situated in their spatial proximity, while these local networks, as open systems, benefit from the long distance connections that some of their members are able to activate. "Distant contexts can be a source of novel ideas and expert insights useful for innovation processes as shown, for instance, in recent patent analyses. Firms therefore develop global pipelines not only to exchange products or services, but also in order to benefit from outside knowledge inputs and growth impulse. Such findings imply that, in a globalising knowledge-based economy, each cluster's economic prospects depend not only on its internal interactions but also on its ability to identify and access external knowledge sources located far away" (Maskell, Bathelt and Malmberg, 2005).

Co-location of actors in a geographical proximity by itself is not a sufficient condition for co-ordination but can contribute to its efficiency, provided the existence of other shared dimensions among agents: organic level, representations, projects, ... So efficient structures can be generally envisaged as drawing benefits from the complementarity between local and global relations. Thus, into what extent may the interactions needs among industrial actors still require geographical proximity? In other terms, what are the conditions under which industrial and innovative performances are heavily conditioned by a durable co-location of

actors, hence how do internal links in a local industrial structure differentiate from but combine with external ones? By evidence, concepts related to the management of local-global interfaces will play here a very central role.

These questions lead us to reconsider the concept of *cluster* usually considered as a spatial concentration of firms and industrial and technological activities. As far as efficiency and performances of "classical" clusters are not only the result of the intensity and quality of internal but also external interactions and coordination, into which extent can we still consider the relevance of interaction structures restricted to bounded geographical areas? On the one hand, territories cannot be considered anymore as closed systems and the question of internal and external co-ordination cannot be regarded separately. On the other hand, co-ordination does not require durable co-location: lot of partners' regular interactions are satisfactorily achieved in spite of long geographical distance. Links are sometimes issued from former co-location, as stated by Grossetti et Bes (2001) about science-industry relationships. Sometimes they can emerge through temporary encounters and sometimes require further temporary meetings. This suggests that clusters should be considered as co-ordination structures less constrained by space and by time. The two aspects of interfaces and dynamics of interactions should then be regarded with a renewed attention about their spatial implications.

In the next section we will discuss of the question of clustering and of geographical proximity when the local advantages of geographical proximity are confronted with the global constraints and opportunities on which leans the performance of the involved firms or establishments. This trade-off appears mostly significant in the case of a growingly knowledge based economy. In the section three we turn our attention to the way industrial actors take into account the question of the local-global articulation for the strategic building of their own ego-network, that is the set of links they may build in order to achieve efficient interactions with partners and competitors. Thus interfaces between local and global relationships are a key feature that can be achieved through different approaches. To this aim we introduce the two concepts of knowledge gatekeeper and temporary proximity that appear as providing alternative approaches of actors partnering, likely to provide a better flexibility in the local-global trade-off. We will then present the basic form of the ego-networks on which the individual firm is able to build her relational neighbourhood. Then the fourth section, will be devoted to the question of the combination of individual ego-networks into a consistent networked structure into which local networks are articulated by the way of local-global interfaces. On this basis we present a typology of the basic new forms of clustering where time and space can be alternatively and complementarily combined in order to achieve more flexibility and costs reduction of the localisation game.

## *2. Clustering and interactions : the local-global trade-off*

The study of the clustering process in the knowledge-based economy focuses on activities that are economically driven by immaterial factors. This framework put emphasis on the reasons that may explain the co-location of these firms. As space is not a direct factor in the production process, space is introduced through the location of the actors which the productive unit is in connection with. The pattern of interactions stems from the characteristics of the activity and contains the explanatory factors of the local/global configurations that we observe (Kogut, 2000).

If we refer to the literature on the subject of knowledge creation and transmission between local firms we can state that knowledge is considered as an exogenous factor that facilitates

clustering. Many papers refer to knowledge as an externality or a local public good (Antonelli, 2000; Bellandi, 2002). In this perspective knowledge is an external factor that can have effects on firms' innovative process and the magnitude of the effect is more or less a function of the number of relationships with other firms or actors (Dyer and Nobeoka, 2000; Kogut and Zander, 1992). Recent models on strategic links formation consider that inter-enterprises links are a way to capture knowledge spillovers as a source of production costs reduction and then modulates the incentives to enter R&D partnerships among competing firms (Goyal and Joshi 2003, Deroïan, 2006).

Clustering can be explained by the idea that knowledge spillovers should be more likely to occur at the local level (referring to the ancient and seminal Marshall's formula that "the secrets of the industry are in the airs"). Empirical studies have seemed to validate this assumption by demonstrating the existence of "local knowledge spillovers". Jaffe, Trajtenberg and Henderson (1993) have provided evidence in this sense from an econometric study of the ties between citing and cited patents as a good indicator of innovations relationships. Even though these approaches shed light on some of the economic advantages of geographical proximity, they put a black box on the dynamics of the knowledge transfers and their relationships with the spatial proximity and clustering process (see Malmberg and Maskell, 2002). Moreover geographical proximity cannot be seen anymore as a source of benefits by itself since Breschi and Lissoni (2003) have shown that it is actually a proxy for social proximity among inventors. More precisely, "localization effects tend to vanish where citing and cited patents are not linked to each other by any network relationship". Knowledge flows are local if and only if they are supported by local labor mobility and interfirms links. Access to knowledge resources in a geographical proximity depends on an active involvement into knowledge exchange networks and skilled workers market. So if space matters it is when and why social links are usually denser in a context of spatial proximity.

Describing knowledge as a local externality makes the implicit assumption that the actors take this phenomenon as given when they make their choice (location, production…). In the study of the knowledge-based economy this hypothesis is somewhat restrictive, because it does not allow to study the process under which interactions are constructed, and how these interactions can support knowledge creation, acquisition or transmission (Breschi and Malerba, 2001). As a matter of facts interactions are not before all local by essence. Geographical proximity as firms co-location is sometimes the sole issue of local development policies. "The geographical framework of economic interactions is widely conditioned by the institutions' game. (…) Seeking synergies among local actors has become the basic rule of most of the policies of local development (…) frequently leading to actors' co-location without giving rise to any notable effect of synergy. Recent inquiries about inter-firms' co-operations show that, in most of the cases, firms co-operation with organizations that are not located in the same region and that interactions of proximity are rather infrequent" (Torre, 2006).

About learning and innovation aspects, geographical proximity doesn't appear per se neither as a necessary nor as a sufficient condition and "should always be examined in relation to other dimensions of proximity that may provide alternative solutions to the problem of coordination"(Boschma, 2005). Malmberg and Maskell (2005) recall that learning would theoretically draw the most benefits from geographical proximity since there exist important dissimilarities and complementarities between the cognitive repertoires of the partners (*learning by interacting*). Such a situation is particularly pronounced with firms' vertical interactions and above all when customers ask for sophisticated demand. Such customers, as a

major source of innovation (Von Hippel, 1988) allow suppliers to formulate and anticipate a coming demand on the global market. Porter (1998) considers the presence of such sophisticated customers as a major feature for improving and upgrading the knowledge level of a cluster. But, as underlined by the authors, empirical studies show that, in the real world, vertical interactions are found in a geographical proximity much lesser that predicted. Geographical proximity usually gathers agents with similar or close cognitive registers, often rivals and competitors. Those latter base their learning on observation and comparison (*learning by monitoring*) but also on the social proximity that generates a "local broadcasting" phenomenon (Owen-Smith and Powell, 2002) or a local "buzz" to resume the concept from Storper and Venables (2004). "Buzz thus refers to the information and communication ecology created by numerous face-to-face contacts as people and firms within the same industry co-locate in the same city, district or region. This buzz consists of specific information and continuous updates of this information; intended and unanticipated learning processes in organized and accidental meetings; the application of the same interpretative schemes and mutual understanding of new knowledge and technologies; as well as shared cultural traditions and habits, which taken together makes interaction and learning less costly" (Malmberg and Maskell, Op.Cit.).

Generally speaking, most of the papers dealing with the knowledge-based economy consider network of relationships as a natural medium to spread information and to establish linkages. But such networks should not be considered from the sole angle of their role as medium; they have also to be considered as an assembly of more restricted sets of links that have been established by individual actors in order to improve the efficiency of their industrial processes (production, innovation or commercialization). We cross there the notion of social capital about which two different traditions have been developed in the sociological literature that have different consequences in the terms of the network topology that should be searched by individual actors. Following the conception of Bourdieu (1980), social capital is a way to access and draw benefits from resources owned or controlled by other actors and is then related to an individualist point of view, where each actor is before all preoccupied by the number and quality of his direct relations (ego-network). On the contrary, the point of view developed by Coleman (1988) has to be understood at the community level and refers to the ingredients of what makes social organization consistent: trust, social norms, social links … The individual benefits of social capital are expected by the involvement of individuals into groups in which the density of relationships is the basic ingredient of efficiency.

Then, understanding the role of these linkages for knowledge use and creation will not be feasible without being aware of how and why they have been constructed. Moreover, spatial clustering analysis cannot be adequately addressed if it is not directly connected with this process of creation and use of networks, where individual ego-networks are the result of individual and bi-lateral decisions of link formation in the context of the whole existing or expected network (accordingly to the concept of pairwise stability in strategic networks analysis). Then assessing the advantages of geographical proximity has to be done with respect to the trade-off between local and non-local linkages in optimization process of the actors' ego-networks.

In this perspective, a clustering process should be considered as an adaptive process of interactions that relies partly on spatial proximity to spread and create knowledge (Feldman M., Aharonson B. and Baum J. , 2005). Therefore, such local arrangement cannot be analyzed as fixed and autonomous by referring only to local amenities that may influence the dynamics of knowledge. It is not supposed that local networks should be efficient per se. Separating

them from their outside connections could drain them of their meaning. Hence, the insertion of local clusters within wider networks is a key feature of the process of knowledge creation and use that opens their renewal and possible recombination (Saxenian, 2005). Local arrangements within a global network take advantage of spatial proximity while keeping outside access to a large variety of resources and opportunities.

This local/global trade-off can be solved by exploring new organizational configurations of these networks that rely on the design of interfaces between local and global networks. But these interfaces are before all the issue of individual firms' strategies of links formation in the aim of building their relational environment, thus their proper ego-network.

## *3. The building of the firm's ego-network and the strategic role of local-global interfaces*

The conceptual basis of our approach is to consider that the interfaces between local and global relationships are a key feature of clusters, but they can be achieved through different network configurations. The diversity of such configurations, as valuable they are, may be considered as a disturbing evidence to rationalize the behavior of the economic agents. If we now consider that the agents face a dynamical process of interactions in an unstable local and global environment they will be reluctant to engage their interaction strategies in a frozen network configuration. Constructing networks for multiple purpose connections will be also too costly to be supported. Alternatively, an efficient way to maintain flexibility of the configurations will be for instance, for rather global actors, to be able to locate for a short time their interactions or, for rather local actors, to build local interactions with a globally connected actor. In that setting, making use of temporary proximity and gatekeepers can be viewed as best response to a same goal, but with a local/global network configuration that is more adapted to the geographical insertion of the firm's economic activity.

Let us consider a population I of firms and a set S of geographical sites. We denote $s_i$ a unit (affiliate or establishment) of a firm $i \in I$ located in a site $s \in S$. There exist three types of links between located units :
$s_i$ - $s_j$ indicates a local link in the site s between to units of distinct firms i and j.
$s_i$ - $t_i$ indicates a distant link between two units of the same firm i located in two distinct sites s and t. It is then a “global” link but within the space of the firm.
$s_i$ - $t_j$ indicates a distant link between two units of distinct firms i and j respectively located in the two sites s and t.

So starting with the question of a firm's ego-network building, let us consider a unit $s_i$ of a firm $i \in I$ located in a site $s \in S$. Two categories of ties are concerned : internal or “local” and external or “global”. At the internal level of the site s, direct local $s_i$ - $s_j$ links may be built with other actors located in the same site. The local links form the local component of the ego-network of the firm i in the site s. At the external level, the question to be addressed is the way $s_i$ is connected to outwards targets, that is to actors in other sites with whom it is suitable to build relationships. There the strategic choice is about the nature of the interface that is likely to be chosen. This can be achieved either as an indirect link $s_i$ - $s_j$ - $t_k$ , by the intermediary of a local actor $s_j$ that is globally connected, or through organizing by herself the distant relations i wants to integrate into her ego-network, on an either durable or temporary mode.

So the question addressed here is related to the nature of local-global interfaces that are used by i to organize her interactions among two or more distant sites, to her "global" markets and partners. We can identify for this three basic configurations that can be most often combined within the whole ego-network of the firm.

The multi-spot configuration (a) is the option to build interfaces near each distant relevant places and to collect directly the information and opportunities. The Gatekeeper configuration (b) put a specific actor in charge of the interface in order to collect and distribute information and opportunities through her multiple connections. Last but not least, the temporary proximity configuration (c) leans on temporary operated interfaces either in a specific third place or on the site of one of the interacting actors.

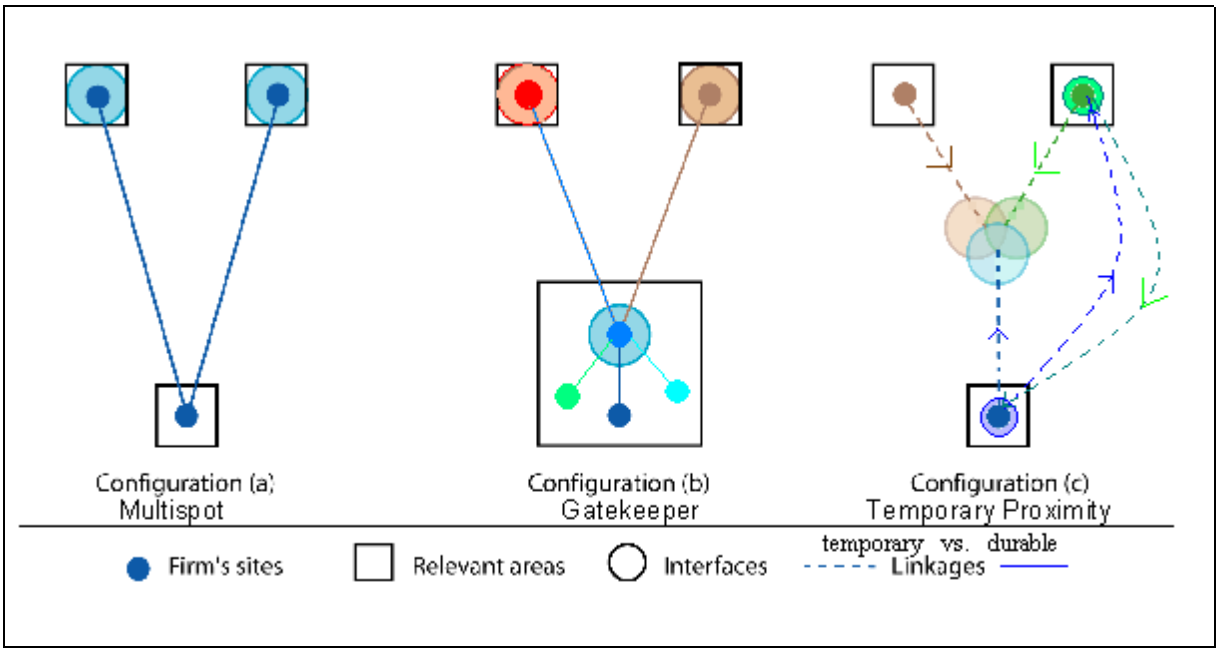



**Figure 1: Ego-networks basic configurations**

Each of these configurations has its proper costs and benefits for the firm. As we are in a dynamic setting, the firm can switch from one configuration to one another (following opportunities and costs) or also combine them. Using them implies different conditions about the actors' consent. A multi-spot configuration (a) does not rely on an agreement with other actors and so is a one-sided decision. A gatekeeper configuration (b) makes the hypothesis that the firm in the interface is willing to distribute information and/or opportunities. Temporary proximity relies on the partners' moving. We will now develop and give more content to these basic components of an ego network

## 3.1. The multi-sites configuration

The firms that rely on a multi-sites configuration follow an optimization process that has been extensively described in spatial economics. Depending on the costs, competition and profits, firms can have incentives to build local units or subsidiaries in order to be as close as possible to the market especially when transportation costs are high or to exploit production opportunities when specific resources have to be exploited. This has been extensively described in the case of multinational corporations as stated among others by Michalet (1985)

who analyses the MNC as an integrated space of knowledge and goods circulation, in which the firm's organization co-ordinates two kinds of subsidiaries typified as "relay" vs. "workshop" subsidiaries. It can also aim to capture the knowledge and innovation potential carried through the requirements of sophisticated users demand in the context of a geographical proximity. As an illustration, the Japanese producer of carbon fibers Toray Inc. decided in the 1980s to locate subsidiaries next to leading users of advanced applications of her products for so diverse productions as sports products (tennis rackets, golf clubs, pleasure boats ...), aerospace industry (space shuttle cabin, helicopter body, ...), automotive industry, medical equipments ... (GEST, 1986).

In such configuration, the rationale is the one of the integrated space of the firm. Interfaces required for market access and resources combinations are built in the localized units, articulating geographical proximity to external actors with the "organized proximity" (Rallet and Torre, 2005) within the multi-sites space of the firm. By definition such configuration only concerns large and rather global firms that can base their organization on a multi-localization internal division of labor. In a dynamic acceptation, flexibility is rather limited and costly in so far as it relies on avoiding any geographical lock-in and preserving the nomadism of the firm. It is achieved through a periodical reassessment of the merits of the firm's global architecture and spatial spreading out. Thus, for the territories this model is also the one of the possible departure of the firm when costs of opportunity lead her to give preference to a given location at the expense of a former one (Zimmermann, 2001).

Nevertheless, such configuration can quite apply to knowledge intensive activities as in the case of the Californian "Cadence", worldwide leader of CAD (computer aided design)[1]. This later decided in 1997 to locate a research center in Sophia Antipolis in the south of France, in order to get closer to users of the new emerging market of electronic CAD like Texas Instruments, ST Microelectronics and Nokia that concentrate an important demand for CAD software for the design of microelectronics circuits. Today the Sophia center is the prime contractor for the new generation of the leader software "Virtuoso", in charge to co-ordinate the development of the product in co-operation with the other teams in San Jose, Bangalore, Moscow and Endimburg. It also benefits from its geographical location in the midway of the other locations, enabling to organize meetings with Moscow or India in the morning and with California, in the afternoon.

## 3.2. The gatekeeper configuration

The Gatekeeper configuration is based mainly on the optimization of the information management with respect to local and global flows. It refers to the concept of *technological gatekeepers* first introduced by Allen (1977) as linking "their organizations to the technological world at large" thus related to "the problem of communication in technology" in a context of R&D organizations. This concept was resuming the former idea of indirect flows of information forwarded through *opinion leaders*. "There will always be some people who, for various reasons, tend to become more acquainted with information sources outside their immediate community. They either read more extensively than most or develop personal contacts with outsiders. A large proportion of these people in turn attract colleagues from within the community who turn to them for information and advice." (Allen, Op.Cit. p.150).

1 See « Comment le californien Cadence coordonne sa R&D depuis Sophia », L'Usine Nouvelle, N°2991, 5 Janvier 2005

According to a more specific meaning, this concept of technological or knowledge gatekeeper can be understood as regarding the role that some few agents can play as managing the local/global interface of co-localized groups of industrial units. Gatekeepers provide to each of the actors a connectivity function that allows them to avoid the cost of maintaining side by side relationships. They have a double role of co-ordination to play.

On the one hand, they contribute to the articulation of internal and external resources, allowing local actors to benefit from their own external relations but also giving external actors access to local resources. In that sense Gannon (2005) describes in the case of the Bologna automatic packaging machinery district in Emily-Romagna (Italy), the "Packaging Valley", how some few enterprises (*commitenti*), organize there network of subcontractors (more or less theoretically interchangeable) and co-ordinate the work of highly specialized SMEs (*terzisti*) to whom they transmit the requirements and specifications of external customers. In the textile district of Prato, "this role is played by the "impannatori" that sometimes specialize in this function so much as to abandon production tasks in order to exclusively devote themselves to it. But in most of the districts, the principals are the most important enterprises that compete on the final market" (Gannon, Op.Cit.).

On the other hand, they play a corollary role in terms of internal co-ordination by animating the local networks of firms, through the mobilization and activation of local skills and complementarities, thus permitting to draw benefits from geographical proximity effects, while allowing a better access to locally lacking resources or to external markets. They provoke or facilitate the emergence of *productive encounters* (Colletis and Pecqueur, 1993) understood as the capability of a group of local actors to bring solutions to productive problems or even to formulate and resolve some new and unprecedented ones.

Leaning on this same Italian packaging machinery case, Malipiero, Munari and Sobrero (2005) stress that technological gatekeepers have a triple role for co-ordinating and stimulating innovation, through capturing external relevant knowledge, absorbing and diffusing it within the cluster : "While the classic perspective on industrial district views the district as an environment inherently conducive to the creation of direct relationships, in which knowledge circulates spontaneously, empirical studies, highlighted the presence of focal firms within industrial clusters -and in more general terms within local economic systems- playing a leading role for the transmission of technology and knowledge. They act as leading firms in the local innovation network, generating new knowledge and technologies, spinning out innovative companies, attracting researchers, investments and research facilities, enhancing other firms R&D activities, stimulating demand for new knowledge and creating and capturing externalities.

This double task of internal co-ordination and local/global interface, is often achieved through structures characterized by a high level of cliquishness[2] at the local scale while a small number of global "shortcuts" give access to the global world as stated in the "small world" approach (Watts and Strogatz, 1998). It also corresponds in terms of network structure to the role of bridging "structural holes" (Burt, 1992) between weakly connected network components or more precisely between a local network and outside networks or actors, for their own benefit and the one of the whole local industrial system.

Nevertheless, as shown by Morrison (2004), in terms of knowledge flows and innovation aims, the gatekeeper role in a local productive system is not always played by the leading

2 In the sense of the likelihood that two individuals linked to a third one are also linked together.

firms into the extent they may redistribute the outside collected knowledge to only a very small number of the district's members. That's the reason why the role of knowledge gatekeeper is often played by non-lucrative institutions for the shared benefit of all the members of the cluster and a deeper territorial anchorage of the innovative and productive activities. It is the case in Sophia Antipolis with "Telecom Valley", a professional association of the actors of the telecommunication sector, and the "Knowledge Management Platform", a project the association has initiated, as shown by Lazaric, Longhi and Thomas (2004).

## 3.3. Temporary proximity

Temporary proximity appears as a way to avoid rigidity of fixed configuration by decentralizing the interface to a temporary meeting place into which part or all of the partners have to make their way. Interactions do not require durable co-location and this for three reasons. First interaction requires partners identification; if partners are not located in a same site this could most often need physical meeting in order to initiate further interactions, through "global-pipelines" (Bathelt, Malmberg and Maskell, 2004) to refer to inter remote sites linkages. Second remote interactions can satisfactorily fulfill the partners' needs. Third inter-firms interactions are generally part time and do not require a continuous face to face.

From these considerations stems the existence and justification of two large categories of temporary proximity. In the first one so-called "temporary clusters" by Maskell, Bathelt and Malmberg (2005), the meeting point comes along with a temporary institution that gives to potential partners a proximity position that permits them to come into contact. In the second one, the firm has to move from her location to the one of her partner either reciprocally or not.

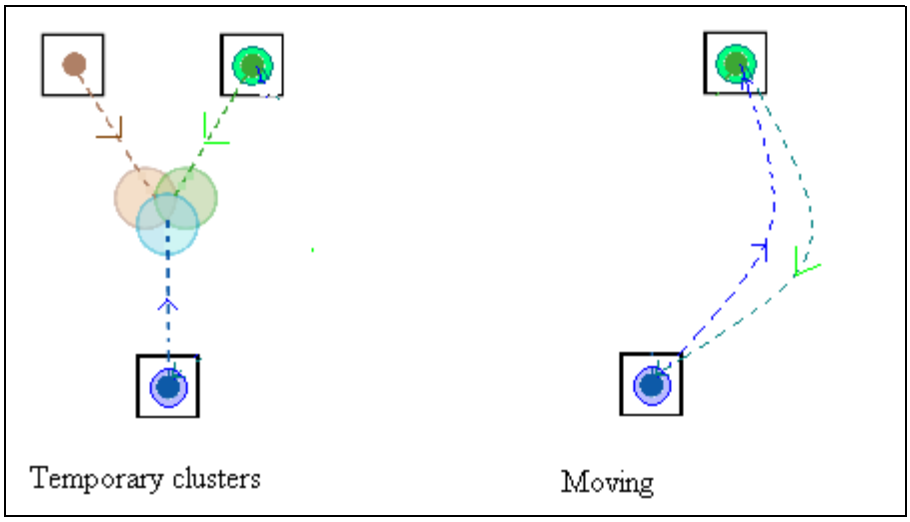



**Figure 2 : Temporary Proximity configurations**

Following Maskell and al. (2005), "identifying, selecting, approaching and interacting with new partners is a tricky and costly process". This is the reason why international fair trades and conventions and, more generally, all kinds of "international professional gatherings" can be a good mean for identifying and approaching such partners. This can be all the more efficient because in such event every attendant presents himself under his most advanced profile to the view and scrutiny of his peers and competitors as well as existing or potential customers or suppliers. So these professional gatherings can be viewed as temporary clusters

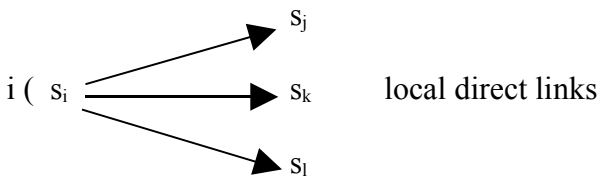
in so far as "they are characterized by knowledge exchanging mechanisms similar to those found in permanent clusters, albeit in a short-lived and intensified form" (Ibidem). Then, those temporary clusters are the place of vertical interactions, likely to be prolonged into long distance relationships, on the contrary to permanent clusters in which they are relatively lacking, as empirical studies have shown (Malmberg and Maskell, 2005) (*learning by interacting*), as well as horizontal interactions among competitors (*learning by monitoring*). Of course these temporary clusters benefit from informal ways of coming into contact (bars, coffee-shops, social events ...) similarly to what exists in permanent clusters. Furthermore, repeated presence in consecutive professional gatherings can sustain a process of trust building between potential partners without any preliminary commitment.

But temporary proximity can also correspond to a bilateral or multilateral relation between still committed partners. As analyzed by Torre (2006), innovation activities and knowledge production only require limited moments of face-to-face interactions and do not necessarily give rise to localized clusters. By the way of more extended mobilities, the geographical proximity constraint can be satisfactorily achieved for a number of interactions, like knowledge sharing and services, through individuals or staff traveling to each other location. Following Gallié and Guichard (2005) these moments of geographical proximity constraints depend on the life cycle and the degree of complexity of the innovation project. Negotiating and outlining a project require face-to-face interaction, using shared equipments generally needs physical presence of the users (when they are not remote controlled), building trust among involved individuals is made easier through direct interpersonal contacts. These can be completed by the way of short or medium-lasting journeys and visits. Leaning on the case of technology transfer and cooperative innovation in biotechnologies, Gallaud and Torre (2004) also show that moments of conflicts between partners usually give rise to better issues when partners arrange together by face-to-face discussions rather than distant communications. Of course, as noted by Torre (2006), "the larger a firm is, the best she can adjust her localizations to the temporal nature of geographical proximity needs. Large enterprises can rid themselves of a strong geographical proximity constraint by moving a part of their staff, may be for relatively long periods, while smaller firms are often restrained to a durable co-location, even though they only need a temporary geographical proximity".

## *4. From firms ego-networks to clusters structure*

So the dual local-global articulation of a located unit $s_i$ is made up trough direct internal and, either direct or mediated, external relations. Distant relations are of either durable or temporary nature :

Internal :




local direct links

External :

$i\,(s \rightarrow t)$ MS ($s_i \longrightarrow t_i$)

TP ($s_i$ ⋯▶ t)

GK ($s_i \longrightarrow s_j$) MS ($s_j \longrightarrow t_j$) or TP ($s_j$ ⋯▶ t)

Hence any inter-sites relationship needs at least a multi-sites or a temporary proximity interface, that can possibly be achieved by the way of one agent playing a role of gatekeeper.

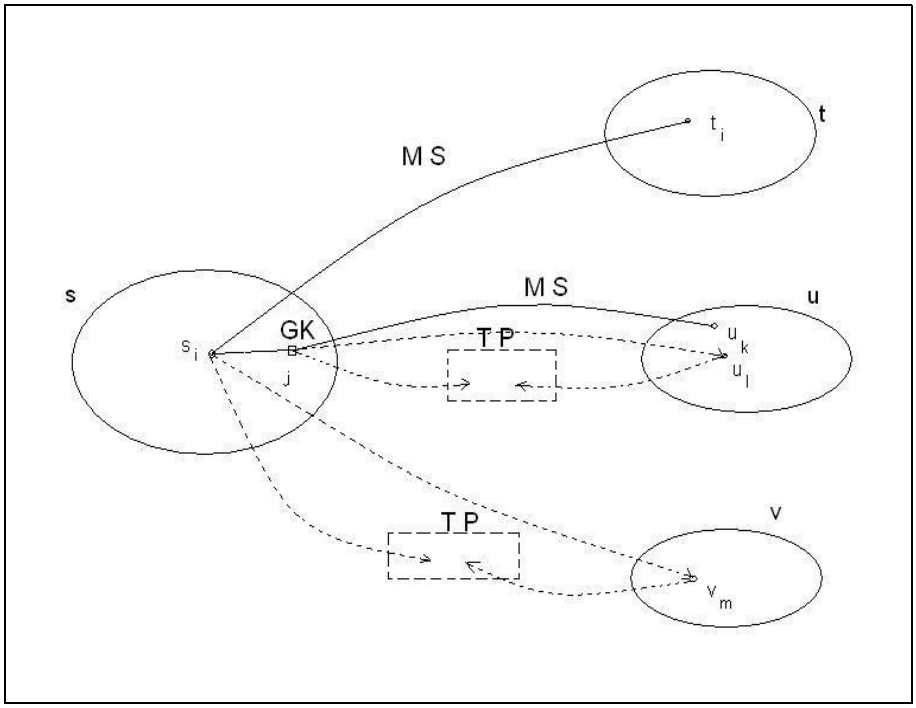



**Figure 3 : inter-sites relationships and interfaces**

Now, how may particular cluster structures emerge from individual agents strategic building of ego-network? In order to progress towards such an aim, we claim that clusters configurations are the structural manifestations of local strategic responses to global constraints. But locality is of course not an actor even if some industrial and technological agents are likely to play a driving role in the coordination game of local behaviors, either for pure individual motives (leading firms) or for local development concerns (local institutions). Thus, the local emerging structure should not be considered as a "best response" to the local/global game, but as a result of the main or maybe dominant strategic choices by industrial actors at a local level or, more precisely, the local projections of firms strategic choices of ego-network formation. So, from confronting local and global patterns would stem specific local networks and the way they do articulate into extended clusters within the global world.

It may be then possible to describe a typology of local area networks that represent the basic forms of local topologies, making use or not, for their external articulation, of the diverse alternative types of interfaces that have discussed. These basic forms can of course be combined in the making of real industrial organization. However they do not necessarily form

clusters, at the level of a single site, in so far as their consistency can rely on external purpose or complementarities.

Three main basic local topologies can then be distinct , as shown in the Figure 4. The first one corresponds to a local network without significant external relationships what doesn't mean isolation or self-sufficiency in so far as this doesn't exclude external market activities. The second type corresponds to a more or less extended local network in which agents do assume their external relation on their own, through multi-site or temporary proximity interfaces. Then the third is a local network making use of a gatekeeper in order to achieve external relations. It has to be noted that the gatekeeper can be an autonomous decision unit or an establishment relying on an external decision unit.

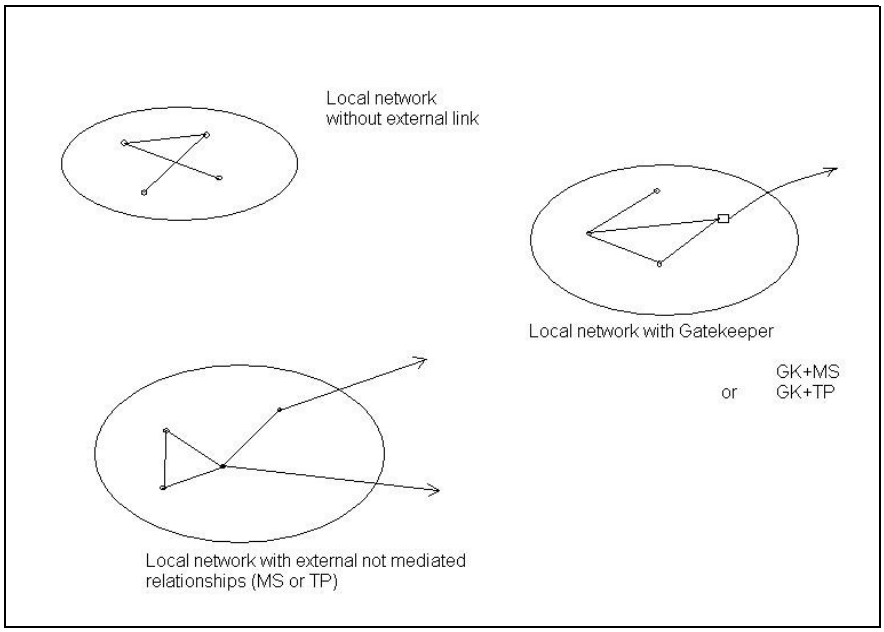



**Figure 4 : Three types of local networks**

Note that the gatekeeper strategy induces per se a clustering rationale . In the case where gatekeeper is the dominant pattern at local as at global level, the industry organizes into strong collaborative local networks with efficient external links giving access to remote complementary resources. The typical structure should be a small-world network with local clusters strongly inserted within global industrial and commercial networks (Zimmermann, 2002). Alternatively the gatekeeper configuration may enter into combinations with the other types of configurations often driven by firms incentives to access to specific or dedicated resources, or to benefit from local externalities or cost effects (agglomeration returns). The other combinations bring more indeterminacy whose issue in clustering terms, when it comes out, is most often the consequence of public policy care. Of course, one important point is the question of the stability of the related structures. The small-world structure is undoubtedly the most likely stable one in so far as it is carried by a set of local gatekeeper patterns articulated into a comprehensive and cohesive structure. The stability of the other combinations will more strongly depend on collective arrangements (see Srivastava and Gnyawali, 2006).

From there, it is now possible to draw the main features of the collective structures stemming from individual strategies of building firms' ego-network. These structures corresponds to a wider, more flexible and more dynamic approach of the concept of cluster, not restricted to

the sole co-location constraint of the geographical proximity. On such purpose, geographical proximity is nowadays considered as a resource rather than a constraint. This embraces new forms of organization that combine space and time and the ability for several agents to play a go-between role within the structure and give rise to actual effects of transitivity. So the industrial fabric takes truly the shape and the nature of a network where inter-individual interactions and knowledge spreading are at the origins of an emerging collective dimension that impacts individual performances. Of course a critical question remains that of the frontiers of such consistent networks of firms that forms extended cluster structures. Here it appears necessary to refer to the regularity and intensity of the links activation, thus of agents interactions what corresponds to the distinction introduced by Granovetter (1973) between "strong" and "week" ties. This raises obviously a problem of subjectivity or at least of the particularity of each case in the absence of possible universal criterion. The critical question here is about the consequences of cutting a link or suppressing an actor on the viability or working of a cluster. Of course any actor may participate to different cluster structures and may possibly play or not a go-between role among them.

By evidence, there is a large number of such structures and it wouldn't be realistic to intend to describe them exhaustively. That's why our claim more simply concerns the description of the basic forms of which these new cluster structures are built, by the way of combination and switching from one to another in the course of time, aiming flexibility and cost-reduction.
That's what we will briefly introduce as a typology.

Typically it is possible to exhibit four large types of basic structures that differentiate by the way they lean on space and time.

1.**Dispersed structures** : they gather geographically dispersed units whose location choices are weakly interdependent and that carry their activities in a at least partial complementarity. Interactions are achieved through transport and telecommunication channels and face-to-face is fulfilled by the way of temporary proximity. So distance can matter but not enough to require co-location. For some of the actors, like specialized suppliers, it is then possible to attain economies of scale by supplying different competitors on different locations.

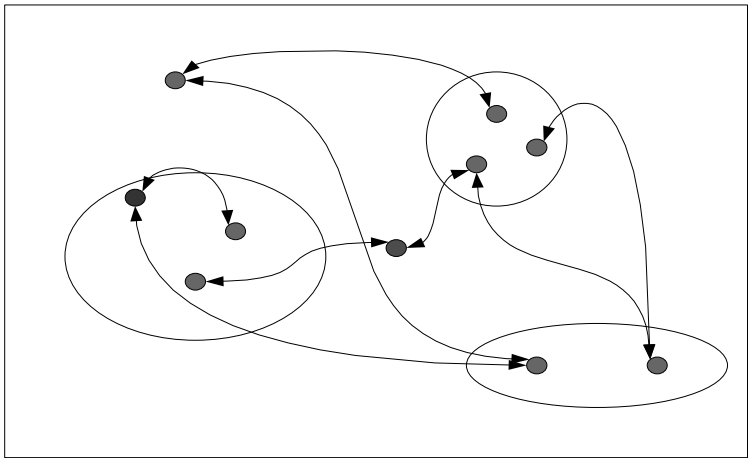


**Figure 5 : Dispersed Structure**

2.**Structural Holes** : a second type of structure combines short and long distance coherence by coupling distant locally connected components by the way of interface capacity and external relationships of gatekeepers. A variant of this type links a connected component to dispersed distant actors, for instance prime contractors.

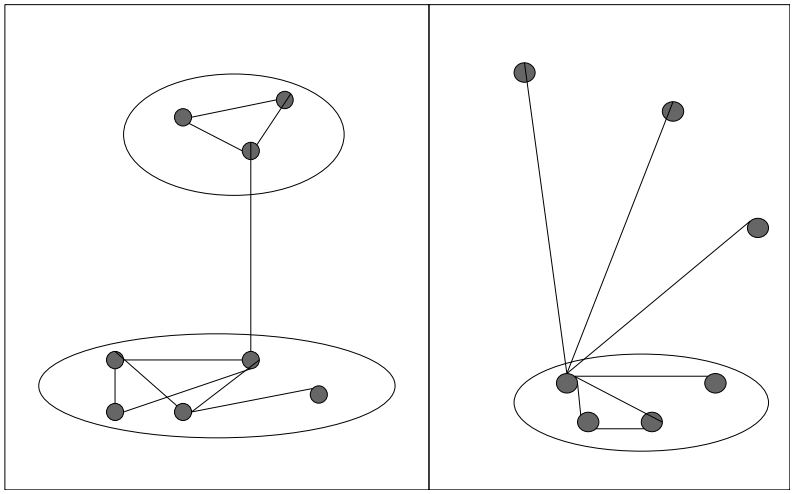


**Figure 6 : Structural Holes**

3.**Interconnected structures** : are formed by densely locally connected components (ie. distant classical clusters) that are interconnected by the way of inter-individual distant links and temporary proximity. These interconnected structures are the result of a strong complementarity between the localized components, possibly based on local differentiated comparative advantages or geographical proximity advantages. Interesting examples are given by the multimedia activity in France between Paris and Marseille or by the software industry between Silicon Valley and Bangalore in India.

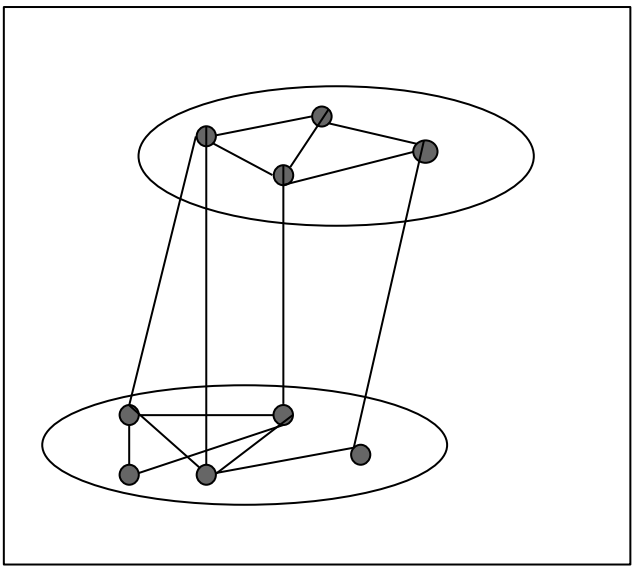


**Figure 7 : Interconnected Structures**

4.**Recombinable structures** : are actually the most flexible shape more likely to be observed when a high level of immaterial nature of the production enables a high efficiency of long distance links and short and medium term temporary proximity. In this case, a given configuration has to be considered as fitted to the specific needs and requirements of a given production and innovation project and its stability may be limited to the time scale of this latter. As projects follow each other as the time goes by, a new configuration can be built by the re-combination of local and distant links, of durable or temporary proximity for a high degree of flexibility required by the successive aims assigned to the cluster. It is for instance the case in the animated film production in Europe, as described in Cole (2004) , where the handicap of the too small sizes of the various studios has been solved by the networking of dispersed European partners while subcontracting routine works to Asia. Such flexible structures aim to possible reconfiguration following the requirements of the projects or the demand. Temporary proximity and gatekeepers are of course the central concepts of such configurations.

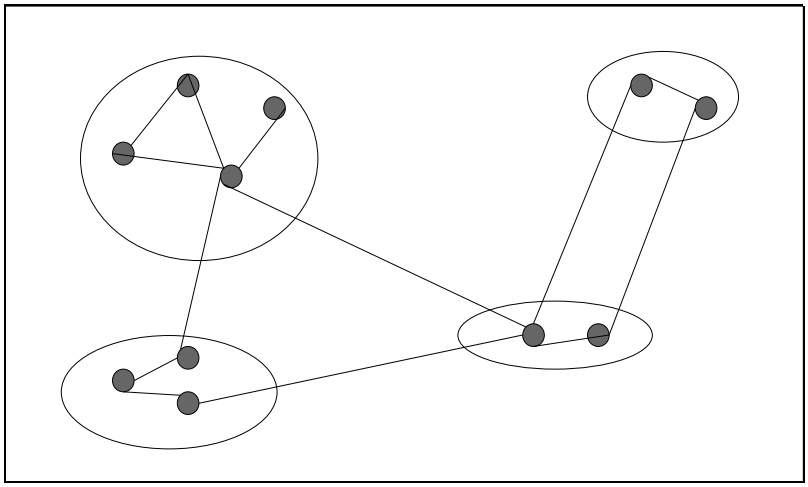


**Figure 8 : Recombinable Structures**

## *Conclusion*

In this paper, we have settled up the bases of a renewed and more dynamic approach of clustering of industrial and technological actors, in the context of a knowledge based economy. This approach stems from the need for actors to take into account the constraints and opportunities of both geographical proximity and globalisation. It is based on the two basic concepts of knowledge gatekeepers and temporary proximity. The aim corresponds, in organization terms, to the necessity to attain a sufficient level of flexibility without having to support high costs resulting from relocating activities, switching from a spatial configuration to another one or the multiplicity of the geographical sites of the enterprise. To these considerations has to be added the idea that geographical proximity doesn't always play in a positive sense. As Torre (2006) shows, there are at least three main negative consequences that can lead to avoid geographical proximity. The first one is the unwanted aspects of local knowledge spillovers that can lead a firm to avoid a location next to her competitors, in so far as knowledge drains can be favored by geographical proximity, for instance through employees turnover. The second one refers to the dangers of a geographical lock-in, that can

lead local production system in a regressive circle, locking it in an over-specialized character, in a growing isolation apart from the outside global dynamics. Last but not least the third negative aspect of geographical proximity stems from a the bad efficiency of the local system of innovation when it is too weekly connected with the outside world. This situation corresponds generally to a local system based on "weak ties, involving firms that share the same knowledge base, satisfying themselves being there and establishing communications for daily tasks. This weak local buzz (Bathelt and al. 2004), if it contributes to the system cohesion, only carries incremental innovations and doesn't favor knowledge spreading and synergies in terms of research and innovation" (Torre, Op.Cit.).

These considerations (negative aspects of co-location, need for flexibility and easier distant coordination) have led us to consider a cluster, understood as a cohesive set of strongly articulated industrial actors, beyond the postulated assumption of co-location, of geographical proximity. For understanding how such structures can emerge leaning on multi-sites locations, we have based our approach on the individual firms strategies of building ego-networks. There, the critical question is related to the way local activities in a given site can connect themselves with other activities in distinct and distant sites. So we have introduced a typology of three basic local-global interfaces that enable us to analyze local network configurations as the structural manifestation of local strategic responses to global constraints. Thus at a collective level, a large scope of structures can be considered that disentangle clustering from a strictly local conception. Of course the topologies of such multi-sites structures will highly depend on the specific characteristics of the related industry or technological field. "The emergence of structure in a network is sensitive to specific industry settings" (Kogut, 2000).

Following the approach we propose here, clusters nowadays have not any more to be considered as strictly local structures, by definition. Of course geography still matters. But the limits and the meaning of agglomeration of industrial and technological activities have no more to be considered in a geographically bounded area. Separated, distant locations can be in strong relationships, following diverse configurations, and these relationships can enter significantly in the way of working and the sources of each participants efficiency. Time and space enter in multiform combinations, engendering more complex structures and replacing the question of the geographical proximity source of benefits in a more open framework. Of course the question of the boundaries of the structure remains tricky and it is important to be able to identify such relevant structures in limited terms in spite of the idea that, with globalization, everything is in everything and reciprocally. That's one of the reason empirical methods of concrete clustering cases analysis have a prior importance to be developed and used.

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